Yukawa Laboratory (Special Issue on the Commemoration of the Fortieth Anniversary)

YUKAWA LABORATORY (January 1943~)

Head: Dr. Hideki Yukawa

The Yukawa laboratory was established in January, 1943. The field of research carried out since 1952 has been concentrated in the following three regions:

I. Meson Physics

II. Fundamental Problems in Theoretical Physics

III. Space-Time Structure of Elementary Particles.

The outline of these works and papers published so far are as follows.

I. Meson Physics

At the same time when the low temperature nuclear fusion processes using μ-meson as catalyzer were discovered by Alvalez et al, the theoretical analysis was performed in this laboratory and the excellent agreement of the theory with the experiment was obtained.[5),6),7),10),11)] After the research of this nuclear fusion problem was accomplished, spectra of mesic atoms were studied which play important role as a probe of nuclear structure.[13),14)] In mesic atoms composed of a nucleus and a meson, the orbital radius of the meson is smaller than that of the ordinal atom in about two orders of magnitude. Consequently the meson feels nuclear structure very sensitively, and on account of this property mesic atoms play important roles in nuclear physics.

II. Fundamental Problems in Theoretical Physics

Some considerations on foundations of theoretical physics have been occasionally taken up. During 1952–1953, the group theoretical structure of quantum mechanics was mainly studied using the Lie theory of continuous transformation groups.[1),2)] During 1956–1957, γ–γ angular correlation of Cd^{111} nucleus was studied and fundamental mistake of Zürich group was indicated.[3),4)] Some fundamental problems concerning high temperature plasma were investigated from 1959 to 1962.[9),12)] In 1959, the possible existence of the electric diploe moment of electron was estimated using the hyperfine structure of hydrogen atom.[8)] Recently quantum theory of measurement is being studied from the standpoint of quantum theory of large body, in contrast with the usual theory of von Neumann which treats measuring processes very mathematically and abstractly.

III. Space-Time Structure of Elementary Particles

Today the number of strange particles and resonances is becoming larger and larger, and many theories present to explain the symmetry scheme of new particles. However, the majority of present theories is based on abstract spaces quite independent of the Minkowski space-time. To correct these defects of present theories,

we are developping the theory of the internal structure of elementary particles closely connected with ordianry space-time. It seems to be necessary to connect the geometrical properties of internal space-time of elementary particles and internal degrees of freedom discovered. In fact, it is possible to introduce the unitary symmetry into the theory by extending Yukawa's non-local filed theory of elementary particles.[15] Group theoretical and differential geometrical methods will be usefull to extend this theory in future. On the other hand, the method of quantization of space-time will also be important to introduce elementary length into the theory of elementary particles. In other words, we are intending to resurrect the spirit of the general theory of relativity in the world of elementary particles.

Publications

(* indicates an article published in Japanese)

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2. H. Narumi: On the Eigenvalue Problem in Terms of a Complete Set of the Casimir Operators, *J. Phys. Soc. Jap.*, **11,** 786 (1956).
3. H. Narumi and S. Matsuo: A Note Concerning the Electric Hexadecupole Moment of the Firt Excited Cd^{111} Nucleus, *Nuovo Cimento*, **6,** 398 (1957).
4. H. Narumi and S. Matsuo: Extranuclear Effects on Angular Correlations of Successive γ-Radiations from the Nucleus Cd^{111}, *Bull. Inst. Chem. Res., Kyoto Univ.*, **35,** 36 (1957).
5. H. Narumi and S. Matsuo: On a Theory of Nuclear Fusion Reactions in Low Temperature (I), *The Doshisha Eng. Rev.*, **9,** 1 (1958)*.
6. H. Narumi and S. Matsuo: On a Theory of Nuclear Fusion Reactions in Low Temperature (II), *The Doshisha Eng. Rev.*, **9,** 143 (1959)*.
7. H. Narumi and S. Matsuo: Note on a Theory of Nuclear Fusion Reactions in Low Temperature, *The Doshisha Eng. Rev.*, **10,** 43 (1959).*
8. H. Narumi and S. Matsuo: On the Possible Existence of Electric Dipole Moments of the Proton and the Electron, *The Doshisha Eng. Rev.*, **10,** 89 (1959).*
9. H. Narumi and S. Matsuo: A Remrak on Rotational Transforms in a Stellarator, *Sci. Eng. Rev. Doshisha Univ.*, **1,** 233 (1960).
10. H. Narumi and S. Matsuo: Non-Adiabatic Effects on the Bound States of the μ-Mesonic Proton-Deuteron System, *Prog. Theor. Phys.*, **25,** 290 (1961).
11. H. Narumi and S. Matsuo: Nuclear Finite Size Effects on the Internal Conversion in the μ-Mesonic He^3 Atom,, *Prog. Theor. Phys.*, **26,** 221 (1961).
12. S. Matsuo and H. Narumi: On the Validity of the Adiabatic Approximation in the Theory of Electron Broadening in a Plasma, *Prog. Theor. Phys.*, **26,** 424 (1961).
13. S. Matsuo: Mesic Atoms, *Nippon Butsuri Gakkaishi,* **19,** 126 (1964).*
14. H. Yukawa and S. Matsuo: Nucleon Polarization Effect on Spectrum of μ-Mesonic Hydrogen Atom, *Bull. Inst. Chem. Res., Kyoto Univ.*, **42,** 422 (1964).
15. S. Matsuo: Structure of Invariants in the wave Equation of n-Dimensional Harmonic Oscillator, *Bull. Inst. Chem. Res., Kyoto Univ.*, **44,** 381 (1966).